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(54) **Non-magnetic one-component developer and development process.**

(57) A non-magnetic one-component developer comprises a binder resin and a colorant, and has a volume-average particle diameter (dv) in a range of 5-15 μm, a ratio (dv/dn) of the volume-average particle diameter (dv) to the number-average particle diameter (dn) in a range of 1.00-1.40, a quotient (Sc/Sr) obtained by dividing the area (Sc) of a circle supposing the absolute maximum length of a particle is a diameter by the real projected area (Sr) of the particle in a range of 1.00-1.30, a product (A*dn*D) of the specific surface area (A) (m^2/g) as measured in accordance with the BET method, the number-average particle diameter (dn) (μm) and the true specific gravity (D) in a range of 5-10, and a ratio (Q/A) of the charge level (Q) (μc/g) to the specific surface area (A) in a range of 15-70. The developer is substantially spherical from both conditions of Sc/Sr and A*dn*D, and is suitable for use in a process for developing an electrostatic latent image formed on a photosensitive body with a developer by using a development apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness. A development process making use of the non-magnetic one-component developer is also disclosed.

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NON-MAGNETIC ONE-COMPONENT DEVELOPER AND DEVELOPMENT PROCESS

FIELD OF THE INVENTION

The present Invention relates to a developer suitable for use in copying machines according to electrophotography and electrostatic recording apparatus, and a development process, and more specifically to a non-magnetic one-component developer excellent in image properties such as image density, resolution and tone reproduction, and a development process making use of the developer.

BACKGROUND OF THE INVENTION

As a development process usable in electrographic copying machines and electrostatic recording apparatus, it has been well known to feed a developer by a feeding member and then make an electrostatic latent image formed on a photosensitive body visible with the developer.

In this development process, there is used a one-component developer composed of a toner alone or a two-component developer composed of a toner and a carrier.

In recent years, various development processes making use of a one-component developer composed of a toner alone have been proposed (for example, U.S. Patent Nos. 3,909,258 and 4,121,931) owing to their merits that an apparatus used therein can be made small and the maintenance of the apparatus is easy.

By the way, a magnetic one-component developer comprising a magnetic powder is involved in the one-component developers. This one-component developer makes use of a magnetic toner having a relatively low specific resistance. It is therefore difficult to electro-statically transfer an image developed on an electrostatic latent image to a support material such as plain paper. In addition, it is impossible to produce color developers because the magnetic one-component developer comprises a large amount of the magnetic powder as a toner.

In more recent years, the spotlight of attention has therefore been focused on development processes making use of a non-magnetic one-component developer free of any magnetic powders and high in specific resistance. The non-magnetic one-component developer generally comprises a binder resin and a colorant such as carbon black and has an advantage in that color developers are obtained.

A development process making use of a non-magnetic one-component developer (hereinafter may referred to as "non-magnetic toner") is performed in the following manner by using, for example, a developing apparatus illustrated in FIG. 1.

Namely, the developing apparatus comprises a photosensitive body 1 and a toner container 2, which is disposed in the vicinity of the photosensitive body 1 and contains a development roll 3 brought into contact under pressure with the photosensitive body 1 and a toner feed roll 4. A development bias voltage is applied to the development roll 3 through an electric source.

A one-component developer 6 composed of a non-magnetic toner is contained in the toner container 2. By rotating the toner feed roll 4, the non-magnetic toner 6 borne on the surface of the roll 4 is transferred to the contact surface with the development roll 3. The non-magnetic toner 6 is further transferred to the photosensitive body 1 as the development roll 3 is rotated, thereby developing an electrostatic latent image formed on the photosensitive body 1.

In this development process, it is important to form a uniform and thin layer of the non-magnetic toner 6 on the development roll 3. For this reason, there is disposed a layer-thickness regulator 7 for controlling the layer of the non-magnetic toner 6 adhered to the surface of the development roll 3 to a uniform thickness.

However, when a toner, which has heretofore been used in the two-component developers and is composed of a binder resin and a colorant, is used as a one-component developer, it is extremely difficult to form a thin, uniform toner layer on the developer roll because the toner cannot be supplied stably. Therefore, the toner cannot be triboelectrified sufficiently, so that it is only possible to obtain a poor image having low density in image areas and full of scumming in non-image areas.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of this invention is to provide a non-magnetic one-component developer, which can be stably supplied to form a thin, uniform toner layer, has good reproductivity for an electrostatic latent image on a photosensitive body, can impart high image density owing to the fact that a sufficient amount of the non-magnetic toner can be transferred from the development roll, and does not bring about defects such as scumming in non-image areas.

Another object of this invention is to provide a development process making use of the non-magnetic one-

component developer having such excellent properties.

A further object of this invention is to provide, in particular, a process for developing in accordance with the reversal development system in which a toner has the same polarity as that of an electrostatic latent image formed on a photosensitive body and/or a process for developing by bringing an electrostatic latent image formed on a photosensitive body into direct contact with a development roll.

The present inventors have carried out an extensive investigation with a view toward overcoming the problems involved in the prior art. As a result, it has been found that the above-mentioned objects can be attained by controlling the shape, particle diameter, particle size distribution, charge level and the like of a non-magnetic toner to specifically limited ranges. The present invention has been led to completion on the basis of this finding.

According to the present invention, there is thus provided a non-magnetic one-component developer suitable for use in a process for developing an electrostatic latent image formed on a photosensitive body with a developer by using a development apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness, characterized in that the developer comprises a binder resin and a colorant, and has the following physical properties:

(a) the volume-average particle diameter (dv) ranging from 5 to 15 μm;

(b) the ratio (dv/dn) of the volume-average particle diameter (dv) to the number-average particle diameter (dn) ranging from 1.00 to 1.40;

(c) the quotient (Sc/Sr) obtained by dividing the area (Sc) of a circle supposing the absolute maximum length of a particle is a diameter by the real projected area (Sr) of the particle ranging from 1.00 to 1.30;

(d) the product (A*dn*D) of the specific surface area (A) (m^2/g) as measured in accordance with the BET method, the number-average particle diameter (dn) (μm) and the true specific gravity (D) ranging from 5 to 10; and

(e) the ratio (Q/A) of the charge level (Q) (μc/g) to the specific surface area (A) ranging from 15 to 70,

said non-magnetic one-component developer being substantially spherical from the conditions of (c) and (d).

According to the present invention, there is also provided a development process, which comprises using the non-magnetic one-component developer as a developer.

According to the present invention, there is further provided, as the above-described development process, in particular, a process for developing in accordance with the reversal development system in which an electrostatic latent image formed on a photosensitive body has the same polarity as that of a non-magnetic one-component developer and a process for developing by bringing an electrostatic latent image formed on a photosensitive body into direct contact with a development roll.

The substantially spherical non-magnetic one-component developer may be prepared by polymerizing an intimate mixture containing at least one vinyl monomer and at least one colorant by a suspension polymerization process.

Here, methods and apparatus for measuring the physical properties of developers in the present invention are as follows.

Sc/Sr is a value obtained by measuring and analyzing a developer by an image processing and analyzing apparatus under the following conditions:

Image processing and analyzing apparatus:
Luzex II D (manufactured by Nikore K.K.)

Percent area of a particle to a frame area:
Maximum 2%

Total number of particles processed: 1,000 particles (The Sc/Sr value is expressed in terms of a number-average value of the 1,000 particles)

The specific surface area (A) as measured in accordance with the BET method is a value measured by means of an automatic specific surface area meter, "Model 2200", manufactured by Shimadzu Corporation, and both volume-average particle diameter (dv) and number-average particle diameter (dn) are values measured by means of a Coulter counter ("Model TA-II", manufactured by Nikkaki K.K.), and the true specific gravity (D) is a value measured by a Beckmann specific gravimeter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary sectional view showing one illustrative construction of developing apparatus to which a non-magnetic one-component developer according to this invention can be applied.

DETAILED DESCRIPTION OF THE INVENTION

Features of the present invention will hereinafter be described in detail.

(Non-magnetic One-component Developer)

Toners have heretofore been prepared by melting and kneading a mixture containing a binder resin and a colorant, cooling the thus-kneaded mixture, grinding it by a grinder and then classifying the thus-ground mixture to make its particle diameter uniform. However, particles of the toners obtained by such a grinding system are indeterminate in shape. In such a toner, the quotient (Sc/Sr) obtained by dividing the area (Sc) of a circle supposing the absolute maximum length of a particle is a diameter by the real projected area (Sr) of the particle generally exceeds 1.3. In addition, its specific surface area (A) as measured in accordance with the BET method is great, and the product (A*dn*D) of the specific surface area (A) (m^2/g), the number-average particle diameter (dn) (μm) and the true specific gravity (D) exceeds 10.

The toner having the shape and properties as described above is poor in flowability. Therefore, when the toner is used as a developer in the above-described development process, a layer of the toner supplied on the development roll becomes uneven, resulting in an image having low density in image areas and full of unevenness in density and of scumming in non-image areas.

On the other hand, since the non-magnetic toner according to the present invention has an Sc/Sr value in a range of 1.00-1.30 and an A*dn*D value in a range of 5-10 and hence is substantially spherical in particle shape, its flowability is good.

When a toner having such properties that the volume-average particle diameter (dv) is in a range of 5-15 μm, the ratio (dv/dn) of the volume-average particle diameter (dv) to the number-average particle diameter (dn) is in a range of 1.00-1.40, preferably, of 1.00-1.25, and the ratio (Q/A) of the charge level (Q) (μc/g) as measured in accordance with the blow-off method (carrier: TEFV 150/250, toner concentration: 5%, measured after mixing and stirring for 30 minutes at a rotational speed of 150 rpm) to the specific surface area (A) is in a range of 15-70, preferably, of 20-60, among substantially spherical toners having above-described features, is used as a developer in the above development process, a uniform, thin layer of the toner is formed on the development roll, the deneseness of the toner onto a latent image formed on the photosensitive body becomes good and the toner particles come to have a fixed and uniform electric charge on their surfaces. Therefore, the transfer efficiency of the toner in the transferring process becomes higher. As a result, an image developed has high density in image areas, and is free of any dust and unevenness, and vivid.

Besides, when the non-magnetic toner according to this invention is used, the triboelectrifying characteristics between the surface of the development roll and the layer-thickness regulator for the toner also become fixed and uniform, so that no scumming occurs in non-image areas even when the toner is used in the contact development system in which an electrostatic latent image formed on the photosensitive body is brought into direct contact with the development roll.

Even in a cleaning process by means of a blade or the like after a transfer process in which a developed image on the photosensitive body is transferred to a support material such as paper, the non-magnetic toner of this invention is substantially removed from the photosensitive body. A small amount of the toner remaining on the photosensitive body, which has not been removed, is also removed by the development roll at the same time as the development in the next developing process. It is therefore possible to obtain stable and good images even in long-term continuous development.

These excellent operational effects can be obtained for the first time as the result that the shape, particle diameter, particle size distribution, charge level and the like of the non-magnetic toner particles have been well balanced with one another.

If particles not satisfying the above-described conditions as to the shape factor (Sc/Sr) and the product (A*dn*D) are used as a toner, the transfer efficiency of the toner becomes low, so that the density in image areas becomes insufficient, and scumming in non-image areas and image unevenness occur on a resulting image.

The use of any non-magnetic toners whose volume-average particle diameter (dv) is smaller than 5 μm or exceeds 15 μm fails to make the layer of the toner on the development roll uniform. Alternatively, its transfer efficiency becomes poor, so that a sufficient image density cannot be obtained.

If a non-magnetic toner having such a wide particle size distribution as the volume-average particle diameter (dv) to number-average particle diameter (dn) ratio (dv/dn) exceeds 1.40 is used, the supply of the toner becomes extremely unstable upon long-term continuous development.

If a toner whose charge level (Q) (μc/g) to specific surface area (A) ratio (Q/A) is lower than 15 or exceeds 70 is used, a sufficient image density cannot be obtained, or a resulting image is full of scumming in non-image

areas. Besides, in the cleaning process after the transfer, the toner on the photosensitive body cannot be removed sufficiently by the cleaning blade because of its too strong adhesion to the photosensitive body, resulting in occurrence of disadvantages such as formation of ghost images.

(Preparation Process of Non-magnetic One-component Developer)

The non-magnetic toner according to the present invention can be obtained by polymerizing an intimate mixture containing at least one vinyl monomer and at least one colorant by a suspension polymerization process.

As a specific suspension polymerization process, there is, for example, a process in which a mixture comprising a vinyl monomer, a colorant and a radical polymerization initiator, and as optional components, various kinds of additives is intimately dispersed by a ball mill or the like to prepare an intimate mixture and the thus-obtained intimate mixture is then finely dispersed in water under high-shear stirring into an aqueous dispersion, thereby subjecting the dispersion to suspension polymerization at a temperature of 30-200°C in general.

As exemplary vinyl monomers useful in the practice of this invention, may be mentioned styrene monomers such as styrene, vinyltoluene and α-methylstyrene; acrylic acid; methacrylic acid; derivatives of acrylic acid and methacrylic acid such as methyl acrylate, ethyl acrylate, propyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, ethyl methacrylate, propyl methacrylate, butyl methacrylate, 2-ethylhexyl methacrylate, dimethylaminoethyl methacrylate, acrylonitrile and acrylamide; ethylenically unsaturated monoolefins such as ethylene, propylene and butylene; vinyl halides such as vinyl chloride, vinylidene chloride and vinyl fluoride; vinyl esters such as vinyl acetate and vinyl propionate; vinyl ethers such as vinyl methyl ether and vinyl ethyl ether; vinyl ketones such as vinyl methyl ketone and methyl isopropenyl ketone; nitrogen-containing vinyl compounds such as 2-vinylpyridine, 4-vinylpyridine and N-vinylpyrrolidone; and the like. These vinyl monomers may be used singly. Alternatively, they may be used in combination to copolymerize them.

In addition to these vinyl monomers, optional crosslinking agents, for example, aromatic divinyl compounds such as divinylbenzene, divinylnaphthalene and derivatives thereof; ethylenically unsaturated dicarboxylicesters such as ethylene glycol dimethacrylate and diethylene glycol dimethacrylate; divinyl compounds such as N,N-divinylaniline and divinyl ether; and compounds containing at least three vinyl groups may be used either singly or in combination.

As exemplary colorants useful in the practice of this invention, may be mentioned pigments and dyes such as carbon black, aniline black, crystal violet, rhodamine B, malachite green, nigrosine, copper phthalocyanine and azo dyes. These colorants may be used either singly or in combination.

In addition, one or more of high-polar substances referred to as charge control agent in this field, such as nigrosine dyes, monoazo dyes, metallized dyes, zinc hexadecylsuccinate, alkyl esters and alkyl amides of naphthoic acid, nitrohumic acid, N,N'-tetramethyldiamine benzophenone, N,N'-tetramethylbenzidine, triazine and metal complexes of salicylic acid may be contained.

It is also possible to simultaneously contain or subsequently add, into the non-magnetic toner according to this invention, at least one of various additives for controlling charge characteristics, electric conductivity, flowability or adhesion properties to a photosensitive body or fixing roll.

Such additives may include releasing agents such as low-molecular weight polyethylene, low-molecular weight polypropylene, various kinds of waxes and silicone oils;

inorganic fine powders such as carbon black powder, silica powder, alumina powder, titanium oxide powder, zinc oxide powder cerium oxide powder and calcium oxide powder; and the like.

(Development Process)

The non-magnetic toner according to this invention is used in a process in which an electrostatic latent image formed on the surface of a photosensitive body is developed with a developer by a developing apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness.

In this case, it may be preferable to develop in accordance with the reversal development system in which the electrostatic latent image formed on the photosensitive body has the same polarity as that of the non-magnetic one-component developer.

Alternatively, it may be preferable to develop by bringing the latent image formed on the photosensitive body into direct contact with the development roll.

ADVANTAGES OF THE INVENTION

According to this invention, there can be provided a non-magnetic toner that when it is used in a process in which an electrostatic latent image formed on the surface of a photosensitive body is developed with the developer by a developing apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness, its denseness onto the latent image is good, its transfer efficiency in a transferring process is high and hence, a vivid image having high density in image areas and free of any dust and unevenness can be formed and moreover, a high image quality free of any scumming in non-image areas can be attained, as compared with the toners in the prior art.

In addition, there can also be provided a non-magnetic toner, which can provide a stable image quality free from the reduction in image density, increase in scumming, occurrence of ghost images and the like even in long-term continuous development, and a development process making use of the toner.

EMBODIMENTS OF THE INVENTION

The present invention will hereinafter be described specifically by the following Examples and Comparative Examples. However, it should be borne in mind that this invention is not limited to these examples only. Incidentally, all designations of "part" or "parts" and "%" as will be used in the following Examples and Comparative Examples mean part or parts by weight and wt.% unless otherwise provided.

Example 1:

Dispersed in a ball mill, were 70 parts of styrene, 30 parts of butyl methacrylate, 4 parts of low-molecular weight polypropylene, 10 parts of carbon black ("Printex 150T", trade name), 1.0 part of a Cr dye ("Bontron S-34", trade name) and 2 parts of 2,2'-azobis(2,4-dimethylvaleronitrile), thereby obtaining an intimate mixture.

The mixture was then added into 350 parts of purified water with 5 parts of calcium phosphate finely dispersed therein to obtain an aqueous dispersion.

The thus-obtained aqueous dispersion was subjected to high-shear agitation by a rotor-stator type homomixer under conditions of at least pH 9 to finely disperse the mixture in water.

This aqueous dispersion was then charged in a reactor equipped with an agitating blade to polymerize the monomer component under stirring for 4 hours at 65°C. After the thus-obtained polymer dispersion was thoroughly washed with an acid and water, the resultant polymer was separated and dried to obtain a toner material.

Subsequently, 0.2 part of hydrophobic silica as a flowability-imparting agent was added to 100 parts of the toner material to obtain a non-magnetic toner.

The thus-obtained non-magnetic toner was composed of substantially spherical particles having properties shown in Table 1.

Using the non-magnetic toner, the evaluation of images was then performed by an apparatus containing an developing machine of the contact development system, which basically has the construction illustrated in FIG. 1, and comprises a photosensitive body 1 making use of an organic photosensitive body, a development roll 3 comprising an electroconductive support of a metallic core and a rubbery toner-bearing layer provided on the outer peripheral surface of the support, and a layer-thickness regulator 7 for the toner made of a urethane rubber.

The resulting images had high density in image areas, and were free of any scumming in non-image areas, dust and unevenness and hence vivid, and moreover stable in image quality even in twenty thousand-sheet continuous developing.

Example 2:

A toner material having a volume-average particle diameter (dv) smaller than that in Example 1 was obtained in the same manner as in Example 1 except that 0.3 part of a Cr dye ("Spiron Black TRH", trade name) was used instead of 1.0 part of the Cr dye ("Bontron S-34", trade name) in Example 1, and 400 parts of purified water with 6 parts of calcium phosphate finely dispersed therein were used as a dispersion medium.

Subsequently, 0.5 part of alumina as a flowability-imparting agent was added to 100 parts of the toner material to obtain a non-magnetic toner. The thus-obtained non-magnetic toner had a volume-average particle diameter (dv) as fine as 5.9 μm and a particle size distribution (the dv/dn ratio) as narrow as 1.20 and was composed of substantially spherical particles having properties shown in Table 1.

Using the non-magnetic toner, the evaluation of images was then performed by the same apparatus as

that used in Example 1.

The resulting images had high density in image areas, and were free of any scumming in non-image areas, dust and unevenness, and moreover extremely good in tone reproduction and definition.

Example 3:

A toner material having a Q/A ratio greater than that in Example 1 was obtained in the same manner as in Example 1 except that 5 parts of carbon black ("Printex 150T", trade name) and 3.0 parts of a Cr dye ("Bontron S-34", trade name) were used as colorants in Example 1.

Subsequently, 0.6 part of hydrophobic silica as a flowability-imparting agent was added to 100 parts of the toner material to obtain a non-magnetic toner. The thus-obtained non-magnetic toner was composed of substantially spherical particles having properties shown in Table 1.

Using the non-magnetic toner, the evaluation of images was then performed by the same apparatus as that used in Example 1.

The resulting images had high density in image areas, and were free of any scumming in non-image areas, dust and unevenness, and hence vivid.

Comparative Example 1:

After melting and kneading 100 parts of a styrenebutyl methacrylate copolymer (styrene:butyl methacrylate = 70:30), 10 parts of carbon black ("Cabot BPL", trade name), 1.0 part of a Cr dye ("Bontron S-34", trade name) and 4 parts of low-molecular weight polypropylene in a kneader, the resulting mixture was ground in a jet mill and then subjected to air classification, thereby obtaining a toner material.

Subsequently, 0.2 part of hydrophobic silica as a flowability-imparting agent was added to 100 parts of the toner material to obtain a non-magnetic toner. The thus-obtained non-magnetic toner had a shape factor (Sc/Sr) of 1.53 and a product (A*dn*D) of 14.6 as shown in Table 1, and was composed of particles having different particle shapes.

Using the non-magnetic toner, the evaluation of images was then performed by the same apparatus as that used in Example 1.

When this non-magnetic toner was used, a layer thickness of the toner on the development roll became uneven, resulting in an image having low density in image areas, and full of scumming in non-image areas and density unevenness.

Twenty thousand-sheet continuous developing was conducted using the toner. As a result, it was found that the image density was sharply reduced and scumming was increased to an extremely great extent as the time went on, and this toner was hence unfit to use in this development system.

Comparative Example 2:

A toner material was obtained in the same manner as in Example 1 except that the Cr dye ("Bontron S-34", trade name) was not used in Example 1.

Subsequently, 0.2 part of hydrophobic silica as a flowability-imparting agent was added to 100 parts of the toner material to obtain a non-magnetic toner.

The thus-obtained non-magnetic toner was composed of substantially spherical particles as shown in Table 1, but had a charge level (Q) (μc/g) to specific surface area (A) ratio (Q/A) as low as 13.

Using the non-magnetic toner, the evaluation of images was then performed by the same apparatus as that used in Example 1.

The resulting images had low density in image areas, scummed over non-image areas and were full of unevenness.

Comparative Example 3:

A non-magnetic toner was obtained in the same manner as in Example 1 except that 5.0 parts of a Cr dye ("Spiron Black TRH", trade name) were used instead of 1.0 part of the Cr dye ("Bontron S-34", trade name) in Example 1.

The thus-obtained non-magnetic toner was in a substantially spherical form as shown in Table 1, but had a charge level (Q) (μc/g) to specific surface area (A) ratio (Q/A) as high as 79.

Using the non-magnetic toner, the evaluation of images was then performed by the same apparatus as that used in Example 1.

The resulting images had low density in image areas and were full of dust, and moreover ghost images were formed in their non-image areas due to high adhesion of the toner to the photosensitive body.

Table 1

	Ex. 1	Ex. 2	Ex. 3	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3
Properties of toner						
Volume-average particle diameter (dv) (m)	12.3	5.9	10.8	12.0	12.6	11.8
Volume-average particle diameter (dv)/ number-average particle diameter (dn) (dv/dn)	1.16	1.20	1.25	1.28	1.18	1.15
Shape factor (Sc/Sr)	1.04	1.06	1.10	1.53	1.03	1.13
BET specific surface area (A) (m^2/g)	0.67	1.46	0.74	1.42	0.70	0.72
Product (A*dn*D)	7.8	8.0	6.8	14.6	8.2	7.4
Charge level (c/g)	25	45	38	28	9	57
Q/A ratio	37	31	51	20	13	79
Evaluation results of image						
Transfer efficiency (%) (*1)	92	90	95	65	70	81
Image density (ID) (*2)	1.47	1.43	1.49	1.03	0.82	1.07
Scumming in non-image areas (*3)	Not occurred	Not occurred	Not occurred	Occurred	Occurred	Somewhat occurred
Image unevenness (*4)	Not occurred	Not occurred	Not occurred	Occurred	Occurred	Occurred
Dust (*5)	Not occurred	Not occurred	Not occurred	Not occurred	Not occurred	Occurred
Ghost image (*6)	Not occurred	Not occurred	Not occurred	Not occurred	Not occurred	Occurred

(*1) Determined by respectively measuring image densities $[ID]_A$ and $[ID]_B$ on the photosensitive body before and after transfer and calculating in accordance with the following equation:

$$\text{Transfer efficiency} = \frac{[ID]_A - [ID]_B}{[ID]_A} \times 100\ (\%)$$

(*2) Determined by measuring a black solid area by a "Macbeth" reflection densitometer.

(*3)-(*6) Evaluated by visually observing image properties such as scumming in non-image areas, image unevenness, dust and ghost image as to each 20,000 copies obtained by the developing apparatus illustrated in FIG. 1.

Claims

1. A non-magnetic one-component developer suitable for use in a development process in which an electrostatic latent image formed on a photosensitive body is developed with a developer by using a development apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness, characterized in that the developer comprises a binder resin and a colorant, and has the following physical properties:
   (a) the volume-average particle diameter (dv) ranging from 5 to 15 μm;
   (b) the ratio (dv/dn) of the volume-average particle diameter (dv) to the number-average particle diameter (dn) ranging from 1.00 to 1.40;
   (c) the quotient (Sc/Sr) obtained by dividing the area (Sc) of a circle supposing the absolute maximum length of a particle is a diameter by the real projected area (Sr) of the particle ranging from 1.00 to 1.30;
   (d) the product (A*dn*D) of the specific surface area (A) (m^2/g) as measured in accordance with the BET method, the number-average particle diameter (dn) (μm) and the true specific gravity (D) ranging from 5 to 10; and
   (e) the ratio (Q/A) of the charge level (Q) (μc/g) to the specific surface area (A) ranging from 15 to 70,
   said non-magnetic one-component developer being substantially spherical from the conditions of (c) and (d).

2. The non-magnetic one-component developer as claimed in claim 1, wherein the dv/dn ratio (b) falls within a range of 1.00-1.25 and the Q/A ratio (e) falls within a range of 20-60.

3. The non-magnetic one-component developer as claimed in claim 1, which has been obtained by polymerizing an intimate mixture containing at least one vinyl monomer and at least one colorant by a suspension polymerization process.

4. A process for developing an electrostatic latent image formed on a photosensitive body with a developer by using a development apparatus equipped with a development roll and a development blade for controlling a layer of the developer supplied on the development roll to a uniform thickness, which comprises using, as the developer, a non-magnetic one-component developer comprising a binder resin and a colorant, and having the following physical properties:
   (a) the volume-average particle diameter (dv) ranging from 5 to 15 μm;
   (b) the ratio (dv/dn) of the volume-average particle diameter (dv) to the number-average particle diameter (dn) ranging from 1.00 to 1.40;
   (c) the quotient (Sc/Sr) obtained by dividing the area (Sc) of a circle supposing the absolute maximum length of a particle is a diameter by the real projected area (Sr) of the particle ranging from 1.00 to 1.30;
   (d) the product (A*dn*D) of the specific surface area (A) (m^2/g) as measured in accordance with the BET method, the number-average particle diameter (dn) (μm) and the true specific gravity (D) ranging from 5 to 10; and
   (e) the ratio (Q/A) of the charge level (Q) (μc/g) to the specific surface area (A) ranging from 15 to 70,
   said non-magnetic one-component developer being substantially spherical from the conditions of (c) and (d).

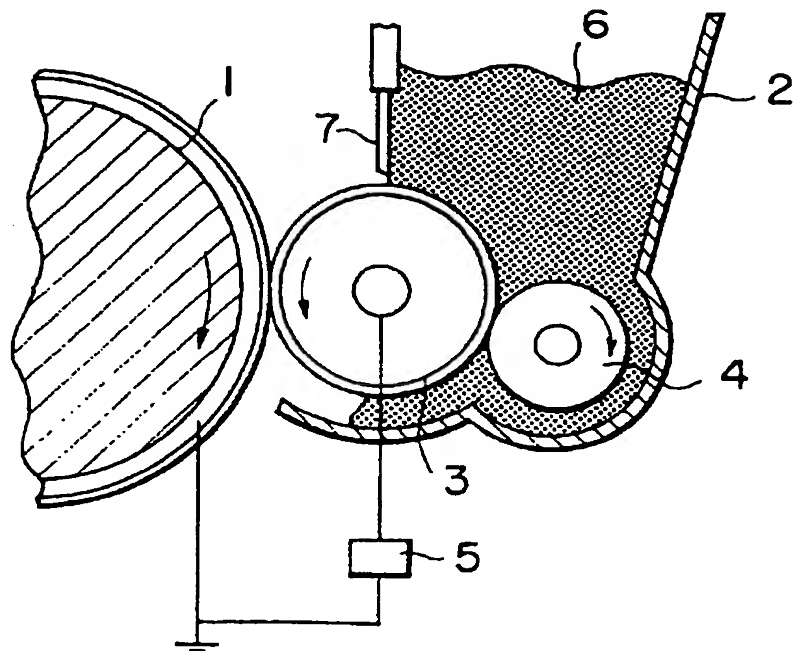
5. The process as claimed in claim 4, which comprises using a non-magnetic one-component developer having a dv/dn ratio (b) in a range of 1.00-1.25 and a Q/A ratio (e) in a range of 20-60.

6. The process as claimed in claim 4, which comprises using a non-magnetic one-component developer obtained by polymerizing an intimate mixture containing at least one vinyl monomer and at least one colorant by a suspension polymerization process.

7. The process as claimed in claim 4, which comprises developing in accordance with the reversal development system in which an electrostatic latent image formed on a photosensitive body has the same polarity as that of a non-magnetic one-component developer

8. The process as claimed in claim 4, which comprises developing by bringing an electrostatic latent image formed on a photosensitive body into direct contact with a development roll.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 1720

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 341 (P-758)(3188) 13 September 1988, & JP-A-63 100466 (NIPPON PAINT CO. LTD.) 02 May 1988, * the whole document *	1-3	G03G9/08
A	GB-A-2091435 (KONISHIROKU PHOTO IND. CO. LTD.) * claims 1-13 *	1-3	
A	EP-A-154433 (MITA IND. CO. LTD.) * claims 1-10 *	1-8	
A	EP-A-335676 (CANON KABUSHIKI KAISHA) * claims 1-67 *	1-8	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 MAY 1991	BATTISTIG M.L.A.

CATEGORY OF CITED DOCUMENTS

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